CLAIMS

1. A process for reducing the energy consumed by a display having a plurality of liquid crystal elements, the light passed by each liquid crystal element being regulated by a capacitive element associated with the liquid crystal element, each capacitive element having the ability to be selectively charged by the delivery of current through a line associated with the capacitive element, the line also driving one or more other capacitances in the display other than the capacitive elements, the process comprising:

a) charging a first one of the capacitive elements and at least a portion of the other capacitances by delivering a current through the line associated with the first one of the capacitive elements; and

b) recovering energy from the portion of the other capacitances without at the same time recovering energy stored in the first one of the capacitive elements.

2. The process of claim 1 wherein the process is repeated for each of the capacitive elements other than the first one of the capacitive elements and wherein energy is not recovered from any of the capacitive elements during the time that energy is recovered from the other capacitances.

3. The process of claim 1 wherein each capacitive element is connected to the line associated with the capacitive element through an electronic switch.

4. The process of claim 1 wherein adiabatic charging is used to charge the capacitive element.

5. The process of claim 4 wherein the adiabatic charging utilizes a ramp signal.

6. The process of claim 4 wherein the adiabatic charging utilizes a staircase signal.

7. The process of claim 4 wherein the adiabatic charging utilizes a half-wave sine pulse.

8. The process of claim 1 wherein adiabatic discharging is used to recover energy from the other capacitances.

9. The process of claim 8 wherein the adiabatic discharging utilizes a ramp signal.

10. The process of claim 8 wherein the adiabatic discharging utilizes a staircase signal.

11. The process of claim 8 wherein the adiabatic discharging utilizes a half-wave sine pulse.

12. The process of claim 1 wherein the display is a liquid crystal display, an electroluminescence display or a field-emission display.

13. A process for reducing the energy consumed by a display having a plurality of liquid crystal elements arranged in a plurality of rows and columns, the light passed by each liquid crystal element being regulated by a capacitive element associated with the liquid crystal element, each capacitive element having the ability to be selectively charged by the delivery of current through a line associated with the capacitive element, the line also driving one or more other capacitances in the display other than the capacitive elements, the process comprising:

a) charging a first one of the capacitive elements and at least one portion of the other capacitances by delivering a current through the line associated with the first one of the capacitive elements; and

b) recovering energy from the portion of the other capacitances without at the same time recovering energy stored in the first one of the capacitive elements or from the capacitive elements that are associated with the liquid crystal elements that are in the same row as the liquid crystal element that is associated with the first one of the capacitive elements.

14. The process of claim 13 wherein the process is repeated for each of the capacitive elements other than the first one of the capacitive elements and wherein energy is not recovered from any of the capacitive elements during the time that energy is recovered from the other capacitances.

15. The process of claim 13 wherein each capacitive element is connected to the line associated with the capacitive element through an electronic switch.

16. The process of claim 13 wherein adiabatic charging is used to charge the

capacitive element.

17. The process of claim 16 wherein the adiabatic charging utilizes a ramp signal.

18. The process of claim 16 wherein the adiabatic charging utilizes a staircase signal.

19. The process of claim 16 wherein the adiabatic charging utilizes a half-wave sine pulse.

20. The process of claim 13 wherein adiabatic discharging is used to recover energy from the other capacitances.

21. The process of claim 20 wherein the adiabatic discharging utilizes a ramp signal.

22. The process of claim 20 wherein the adiabatic discharging utilizes a staircase signal.

23. The process of claim 20 wherein the adiabatic discharging utilizes a half-wave sine pulse.

24. The process of claim 13 wherein the display is a liquid crystal display, an electroluminescence display or a field-emission display.

25. A circuit for reducing the energy consumed by a display having a plurality of liquid crystal elements, the light passed by each liquid crystal element being regulated by a capacitive element associated with the liquid crystal element, each capacitive element having the ability to be selectively charged by the delivery of current through a line associated with the capacitive element, the line also driving one or more other capacitances in the display other than the capacitive elements, the circuit comprising:

a) a voltage connection system connected to the line for controllably causing the line to connect to a voltage source;

b) a recovery connection system connected to the line for controllably causing the line to connect to a reservoir; and

c) a control system for causing the voltage connection system to connect the line to the voltage source during a first time period and for causing the

recovery connection system to connect the line to the reservoir during a second time period, the voltages on the capacitive elements associated with the line not being materially changed during the second time period.

26. The circuit of claim 25 wherein:

a) the source and reservoir constitute a supply that generates a signal that facilitates adiabatic charging and discharging;

b) said voltage connection system includes a first electrical switching system connected between the supply and the line;

c) said recovery connection system includes a second electrical switching system connected between the supply and the line; and

d) said control system controls said first and second electrical switching systems.

27. The circuit of claim 26 wherein the signal includes a ramp signal.

28. The circuit of claim 26 wherein the signal includes a staircase signal.

29. The circuit of claim 26 wherein the signal includes a half-wave sine pulse.

30. The circuit of claim 26 wherein said first electrical switching system includes a transmission gate connected in series with a MOSFET.

31. The circuit of claim 26 wherein said second electrical switching system includes a MOSFET.

32. The circuit of claim 26 wherein said second time period begins a pre-determined amount of time after said first time period.

33. The circuit of claim 26 wherein said second time period begins when the voltage of the signal is approximately equal to the voltage of the line.

34. The circuit of claim 33 further including a comparator circuit connected to the supply and to the line for determining when the voltage of the supply is substantially equal to the voltage of the line.

35. The circuit of claim 25 wherein the display is a liquid crystal display, an electroluminescence display or a field-emission display.

36. A circuit for reducing the energy consumed in driving a capacitive load

that is being driven to a controllable voltage level, comprising:

a) a voltage connection system connected to the capacitive load for controllably causing the capacitive load to connect to a voltage source and for charging the capacitive load using adiabatic charging;

b) a recovery connection system connected to the capacitive load for controllably causing only a portion of the capacitive load to connect to a reservoir and for discharging only a portion of the load using adiabatic discharging; and

c) a control system for causing the voltage connection system to connect the capacitive load to the voltage source during a first time period and for causing the recovery connection system to connect the capacitive load to the reservoir during a second time period.

37. The circuit of claim 36 wherein the adiabatic charging and discharging use a ramp signal.

38. The circuit of claim 36 wherein the adiabatic charging and discharging use a staircase signal.

39. The circuit of claim 36 wherein the adiabatic charging and discharging use a half-wave sine pulse.

40. Apparatus for charging and discharging a capacitive load comprising:

a) a voltage regulator having an input connected to a voltage source, an output, and a control connected to a voltage approximately equal to the voltage to which the capacitive load is to be charged;

b) a first switch having an input connected to said output of said voltage regulator, an output connected to the capacitive load, and a control connected to a first control signal; and

c) a second switch having an input connected to the capacitive load, an output connected to the voltage source, and a control connected to a second control signal.

41. The apparatus of claim 40 wherein said first and second control signals are not activated at the same time.

42. Apparatus for generating a control signal used to activate the energy

recovery phase of an apparatus for driving a capacitive load when the voltage of an energy recovery signal becomes approximately equal to the voltage across the capacitive load comprising a comparator having a first input connected to the voltage across the capacitive load, a second input connected to the energy recovery signal, and an output that constitutes the control signal.

43. Apparatus for sampling a desired voltage that is being delivered to a capacitive load, for preserving that voltage for later processing, and for delivering the preserved voltage to a device for later processing, comprising:

a) a first switch having an input connected to the desired voltage, a control connected to a control signal, and an output;

b) a capacitor connected to the output of said first switch; and

c) a voltage regulator having an input connected to a voltage source, a control connected to said capacitor, and an output connected to the device.

44. A method for driving one of a plurality of capacitive elements and one or more other capacitance-generating components that are associated with a line other than the capacitive elements, comprising:

a) electrically connecting each of the plurality of capacitive elements to the line;

b) storing charge in the one of the plurality of capacitive elements through the line while each of the other of plurality of capacitive elements is electrically connected to the line; and

c) recovering energy stored in the other capacitance-generating components while maintaining the charge stored in the one of the plurality of capacitive elements.

45. The method of claim 44, further comprising electrically isolating the one of the plurality of capacitive elements from the line prior to recovering the energy stored in the other capacitance-generating components.

46. The method of claim 44, wherein adiabatic charging is used to charge the one of the plurality of capacitive elements along with at least a portion of the capacitance-generating components.

47. The method of claim 46, wherein the adiabatic charging uses a ramp signal.

48. The process of claim 46, wherein the adiabatic charging uses a staircase signal.

49. The process of claim 46, wherein the adiabatic charging uses a half-wave sine pulse.

50. The method of claim 44, wherein adiabatic discharging is used to recover energy from the other capacitance-generating components.

51. The method of claim 50, wherein the adiabatic discharging uses a ramp signal.

52. The process of claim 50, wherein the adiabatic discharging uses a staircase signal.

53. The process of claim 50, wherein the adiabatic discharging uses a half-wave sine pulse.

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54. The process of claim 44, wherein the capacitive elements form pixels of a display.

55. The process of claim 44, wherein the display is one of a liquid crystal display, an electroluminescence display, and a field-emission display.

56. The process of claim 44, wherein the capacitive elements form at least a portion of a capacitive electrostatic transducer.

57. A method for reducing the energy consumed in driving a capacitive load that is being driven to a controllable voltage level, comprising:

a) controllably causing the capacitive load to connect to a voltage source;

b) charging the capacitive load using adiabatic charging;

c) controllably causing only a portion of the capacitive load to connect to a reservoir; and

d) discharging only a portion of the load using adiabatic discharging.

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58. A process for reducing the energy consumed by a display having a plurality of liquid crystal elements arranged in a matrix of rows and columns, the light

passed by each liquid crystal element being regulated by a capacitive element associated with the liquid crystal element, each capacitive element having the ability to be selectively charged by the delivery of current through a line associated with the capacitive element, the line also driving one or more other capacitances in the display other than the capacitive elements, each of the plurality of liquid crystal elements being driven to the approximate voltage of a serial video signal, the process comprising:

a) storing the voltage of the video signal for each capacitive element in a storage device;

b) applying the stored voltage for each capacitive element to each capacitive element through a first voltage regulator; and

c) recovering energy from the other capacitances using a second voltage regulator.

59. The process of Claim 58 wherein adiabatic charging is used in applying the stored voltage.

60. The process of Claim 58 wherein adiabatic discharging is used in recovering the energy.

61. The process of Claim 58 wherein the first and second voltage regulators constitute the same device.

62. Apparatus for charging a capacitive load to a controllable voltage level comprising:

a) a connection for receiving a signal representative of the controllable voltage level;

b) a time-varying voltage supply for generating a time-varying voltage that varies from a voltage at one time that is less than the controllable voltage level to a voltage at another time that is greater than the controllable voltage level;

c) an electronic switch in communication with the time-varying voltage supply and the capacitive load for opening and closing a connection between said time-varying voltage supply and the capacitive load to be charged; and

d) a control circuit connected to said electronic switch for causing said switch to close at a point in time when the magnitude of the voltage on the capacitive

load is less than the magnitude of the controllable voltage level and for causing said switch to open at a point in time when the magnitude of the voltage on the capacitive load is close to or equal to the magnitude of the controllable voltage level.

63. The apparatus of Claim 62 wherein said time-varying voltage supply generates a ramp signal.

64. The apparatus of Claim 62 wherein said time-varying voltage supply generates a staircase signal.

65. The apparatus of Claim 62 wherein said time-varying voltage supply generates a half-wave sine pulse.

66. The apparatus of Claim 62 wherein said control circuit communicates the signal representative of the controllable voltage level to said electronic switch.

67. The apparatus of Claim 66 wherein the signal representative of the controllable voltage level is connected to said electronic switch.

68. Apparatus for discharging a capacitive load from a voltage level comprising:

a) a time-varying voltage supply for generating a time-varying voltage that varies from a voltage at one time that is more than the voltage level to a voltage at another time that is less than the voltage level;

b) an electronic switch in communication with the time-varying voltage supply and the capacitive load for opening and closing a connection between said time-varying voltage supply and the capacitive load to be discharged; and

c) a control circuit connected to said electronic switch for causing said switch to close at a point in time when the magnitude of the time-varying voltage supply is equal to or less than the magnitude of the voltage level on the capacitive load and for causing said switch to open at a point in time after the capacitive load has been substantially discharged.

69. The apparatus of Claim 68 wherein said time-varying voltage supply generates a ramp signal.

70. The apparatus of Claim 68 wherein said time-varying voltage supply generates a staircase signal.

71. The apparatus of Claim 68 wherein said time-varying voltage supply generates a half-wave sine pulse.

72. The apparatus of Claim 68 wherein a signal representative of the voltage level is connected to said electronic switch.

73. A process for charging a capacitive load to a controllable voltage level comprising:

a) receiving a signal representative of the controllable voltage level;

b) generating a time-varying voltage with a time-varying voltage supply that varies from a voltage at one time that is less than the controllable voltage level to a voltage at another time that is greater than the controllable voltage level;

c) closing a connection with an electronic switch between the time-varying voltage supply and the capacitive load to be charged at a point in time when the magnitude of the voltage on the capacitive load is less than the magnitude of the controllable voltage level; and

d) opening a connection with an electronic switch between the time-varying voltage supply and the capacitive load to be charged at a point in time when the magnitude of the voltage on the capacitive load is close to or equal to the magnitude of the controllable voltage level.

74. A process for discharging a capacitive load from a voltage level comprising:

a) generating a time-varying voltage with a time-varying voltage supply that varies from a voltage at one time that is more than the voltage level to a voltage at another time that is less than the voltage level;

b) closing a connection with a switch between the time-varying voltage supply and the capacitive load to be discharged at a point in time when the magnitude of the time-varying voltage supply is equal to or less than the magnitude of the controllable voltage level on the capacitive load; and

c) opening a connection with a switch between the time-varying voltage supply and the capacitive load to be discharged at a point in time after the capacitive load has been substantially discharged.